

CLAIMS

What is claimed is:

1. A method of magnetic resonance imaging (MRI) in a body using steady-state free precession with material separation comprising the steps of:
 - a) placing the body in a magnetic field,
 - b) applying axial magnetic fields to the body,
 - c) applying a plurality of RF excitation pulses to the body at a repetition rate, TR, to flip nuclei spins,
 - d) imaging nuclei spins at an echo time, TE, at one-half TR,
 - e) rewinding all gradients over the repetitive time, TR, and
 - f) measuring refocused MRI signals with the phases of the measured signals being used to separate materials.
2. A method as defined by claim 1 wherein the body includes a first species with a resonant frequency f_1 and a second species with a resonant frequency f_2 , where TR and scan center frequency are chosen such that an odd number of phase transitions are between f_1 and f_2 whereby signal phase can be used to separate the two species.
3. The method as defined by claim 2 wherein a first species, blood, is imaged and a second species, lipid is suppressed.
4. The method as defined by claim 3 wherein repetitive rate, TR, and scan center frequency are selected as the reciprocal of resonant frequency differences between lipid and water whereby water and lipid spectral signal peaks occur in successive signal pass-bands.
5. The method as defined by claim 4 wherein the phase angles of water and of lipid signal peaks vary by 180 degrees.

6. The method as defined by claim 2 wherein the steady-state free precession imaging is selected from the group consisting of Cartesian imaging, radial imaging, echo-planar imaging, and spiral in-spiral out imaging.

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7. The method as defined by claim 2 and further including the step of moment nulling over the repetitive time for imaging moving material.

8. The method as defined claim 7 wherein the moment nulling occurs over a repetition time in three dimensions.

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9. The method as defined by claim 1 wherein the body includes water with a resonant frequency f_w and lipid with a resonant frequency f_l , where TR and scan center frequency are chosen such that an odd number of phase transitions are between f_w and f_l whereby signal phase can be used to separate the two species.

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10. The method as defined by claim 9 wherein bone marrow and fat are imaged.

11. The method as defined by claim 9, wherein repetitive rate, TR, is selected as the reciprocal of resonant frequency differences between lipid and water, whereby water and lipid spectral signal peaks occur in successive signal pass-bands.

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12. The method as defined by claim 11 wherein the phase angles of water and lipid signal peaks vary by 180 degrees.

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13. The method as defined by claim 1 wherein the steady-state free precession imaging is selected from the group consisting of Cartesian imaging, radial imaging, echo-planar imaging, and spiral in-spiral out imaging.

14. The method as defined by claim 1 and further including the step of moment nulling over the repetitive time for imaging moving material.

15. The method as defined claim 14 wherein the moment nulling in three-dimensions
5 occurs over a repetition time in three dimensions.